

Measures of environmental stress in non-adult skeletons from pre- and post-industrial communities in England. M.E. LEWIS. The Calvin Wells Laboratory, Department of Archaeological Sciences, University of Bradford, Bradford BD7 1DP. U.K.

The health and survival of the children from any given society is widely believed to indicate the level to which a population has adapted to the environment in which they live. Four non-adult skeletal samples from England were examined to test the hypothesis that the transition from a rural to a post-industrial environment was detrimental to human health. Growth measurements, age-at-death profiles, metabolic diseases and frequencies of indicators of stress were recorded, and their sensitivity to the diverse environmental factors was explored.

Growth curves revealed that all the groups fell below the 50th percentile provided by the modern standard and, that the non-adults from the post-industrial community were shorter than their counterparts for the first six years. The prevalence of stress indicators between the groups was not significantly different, but caries was higher in both urban communities and probably reflects contrasting diets. The prevalence of rickets and scurvy was noticeably higher in the children from post-industrial London, at a time when infant feeding practices changed and levels of environmental pollution soared.

This study shows the importance of the analysis of non-adult remains and the use of palaeopathology for interpreting the impact of changing environments on population morbidity and mortality.

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Adaptations of Fayum Primates. P.J. LEWIS and E.L. SIMONS, Duke University Primate Center, Durham, North Carolina, 27705.

Primates from the Fayum Oligocene and Eocene show a broad range of adaptive strategies. Morphological diversity is best demonstrated in dental features, as many Fayum primate species are only known from one or a few mandibles. However, where facial and postcranial characteristics can be determined they have proved useful. Primate diversity and ecological compartmentalization at the Fayum are best documented in two levels: 1) primates of two essentially synchronous Upper Sequence Oligocene quarries, I and M; 2) within the fauna of the lowermost quarry L-41, located near the base of the Lower Sequence, Jebel Qatrani Formation. A temporally intermediate primate fauna (from quarries E, G, V and R) is less well documented.

A review and comparison of the characteristics of the Fayum primates is undertaken with the goal of showing patterns of adaptation and of correlating this variation with inferred paleoenvironmental conditions. This contribution focuses on several areas: 1) the presence or absence, orientation, and relative size of the incisors; 2) the proportional size of the canines; 3) the comparative size and degree of enamel thickness of the premolars and

molars; 4) tooth crown microwear; 5) relative orbital and brain size; and 6) postcranial evidence.

Early higher primate history is best documented from Fayum primates for several reasons: 1) high primate diversity (currently the range of Fayum species are ranked in five or more different families); 2) first contemporaneity of undoubted anthropoids and prosimians; and 3) comparative completeness of the primate material which often includes skulls and postcrania. Both Order Primates and Suborder Anthropoidea have been suggested as having arisen in Africa. For these reasons, the Fayum primates are critical to the understanding of early primate evolution.

Allometry and postnatal development of pelvic sexual dimorphism in primates. Y. LI, Department of Cell Biology and Anatomy, The Johns Hopkins University School of Medicine, Baltimore, MD 21205.

Previous studies have suggested that variation in degree and in pattern of pelvic sexual dimorphism is driven by fetal-maternal cephalo-pelvic disproportion and phylogeny, respectively (Schultz 1949, Leutenegger 1974, Tague 1991). This study aims to characterize the developmental basis of variation in pelvic sexual dimorphism in *Saimiri sciureus*, *Alouatta seniculus*, *Hylobates lar*, and *Pan troglodytes*, species contrasting in cephalo-pelvic disproportion and phylogeny.

Three-dimensional coordinates of 16 landmarks were recorded using 250 articulated pelvises from museum collections. Sexual dimorphism of pelvic form and growth pattern was studied for each species using Euclidean Distance Matrix Analysis. Those pelvic dimensions found to be dimorphic in these analyses were then plotted against measures of body size to assess relative pelvic sexual dimorphism within each species.

Species with higher cephalo-pelvic ratios (*S. sciureus* and *H. lar*) have greater sexual dimorphism in pelvic form and growth pattern along obstetrically critical dimensions of the pelvis. This is due to either the earlier onset of the accelerated growth of these dimensions in females in proportion to their body size (*S. sciureus*), or the reduced growth of these dimensions in males in proportion to their body size (*H. lar*). In contrast, species with low cephalo-pelvic ratios lack apparent sexual dimorphism in pelvic form and growth pattern, except in *A. seniculus* where females are relatively larger than males along transverse dimensions of the birth canal.

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Temporomandibular translation in non-human primates and hominids. D.E. LIEBERMAN Dept. Anthropology, The George Washington University, Washington DC 20052 and A.W. CROMPTON Museum of Comparative Zoology, Harvard University, Cambridge MA 02138.

The functional basis for temporomandibular translation, in which the mandibular condyles slide antero-posteriorly during jaw abduction and adduction, has been the subject of considerable debate, and is important for interpreting variations in primate and hominid temporomandibular joint (TMJ) morphology.

This study tests the hypothesis that translation is, in part, a function of mandibular ramus height because translation serves as an adaptation to maintain centric occlusion during mastication. Increases in mandibular ramus height are a common adaptation among mammals, including extant and fossil primates, for augmenting the mechanical advantage of the jaw adductor muscles. Increases in mandibular ramus height, however, have the drawback of introducing an anteriorly-oriented component to the trajectory of the mandibular teeth during occlusion. We present a model to show that retraction of the condyles during adduction counteracts this anteriorly-oriented trajectory. As a result, the degree of translation is predicted to be a function of the vertical distance between the plane of occlusion and the glenoid fossa.

The model is tested using sexed crania of 42 primate, herbivore and carnivore species which sample a diverse range of body sizes and mandibular forms. Antero-posterior dimensions of the TMJ were measured to estimate the degree of translation, and several measures of ramus height were taken to assess the vertical distance between the plane of occlusion and the glenoid fossa. The results show that when the effects of overall cranial size are removed there is a strong, positive allometric relationship between the height of the mandibular ramus and the antero-posterior length of the TMJ in which translation occurs among primates and herbivores. In contrast, this relationship exhibits negative allometry among carnivores who have restricted condylar translation. When the model is applied to robust australopithecines whose glenoid fossae are absolutely long, their TMJ dimensions are what one would predict given estimates of their mandibular ramus height.

How "Caucasoids" got such big crania and why they shrank: changing hierarchies of race, brain size and intelligence from Morton to Rushton. LEN LIEBERMAN, Anthropology, Central Michigan University, Mt. Pleasant, MI 48859.

In the 19th Century, S.G. Morton reported cranial measurements for "Caucasians" larger than among "Mongolians" and "American Indians," followed by Africans. In the 20th Century a non-hierarchical view emerged under the leadership of anthropologists. Starting in the 1980s, J.P. Rushton turned Morton's conclusion topsy turvy by reporting that "Mongoloids" have larger cranial capacity, and linking cranial size to IQ scores. Variations in

"intelligence" are then used to explain "race" differences in behavior (illegitimacy, crime, social class, intercourse, frequency, divorce, etc.).

This paper asks why the turn around occurred and critiques the scientific basis of old and new determinism. The analysis addresses the use by Rushton of the invalid concept of race, the numerous variables affecting brain measurements, comparative meaning of brain size differences, Rushton's evolutionary scenario, the r/k idea, contrary genetic evidence, Rushton's 5% explanation, and sociocultural influences. Conclusion: the question of which "race" has the largest cranial size and intelligence is devoid of conceptual and empirical merit.

Climate and body form in Australian Aborigines. P.A. LINDSELL, Department of Archaeology and Palaeoanthropology, University of New England, Armidale, NSW, Australia

In this paper, geographical variation in the body morphology of indigenous Australians is examined. The data for this study was collected by Joseph Birdsell earlier in this century and comprises anthropometric measurements from 2400 men and women of unbroken Aboriginal descent. A number of gross body measurements and proportional indices were used in correlation analysis with geographic and climatic variables.

In general terms, indigenous Australians show geographic patterning in body size similar to that found in sub-Saharan Africa, in opposition to the world-wide trend used to support Bergmann's rule in humans. However, the patterning of body shape and relative body proportions are consistent with world trends and are supportive of Allen's rule.

The implications of these results are discussed in relation to the debate over the origins of modern humans.

The southern Levant: Corridor to Nubia. Peopling of the Eurafian-South Asian triangle IV. J. G. LIPSCHULTZ and C. G. Turner II, Department of Anthropology, Arizona State University, Tempe, AZ 85287-2402.

Based on the assumption of limited external gene flow, several diachronic analyses of Nubian odontometrics, dental morphology, and craniofacial variation propose there was biological continuity between successive populations in Nubia since the late Pleistocene.

Rejecting continuity, several more recent dental morphology studies, which allow for the possibility of external gene flow, propose that the late Pleistocene Nubians were not solely (if at all) ancestral to later Nubian groups, and that post-Pleistocene population replacement may have occurred in Nubia via extra-regional, southward-moving gene flow or migration. None of these studies employs comparative samples from the geographically proximate southern Levant, from whence gene flow might have originated.

The present study tests the null hypothesis of biological continuity in Nubia, and tests the hypothesis of the region of origin of proposed gene flow, by comparing Nubian dental morphology data with geographically and temporally appropriate samples from the southern Levant.

The data for this study consist of all available Natufian and most Pre-Pottery Neolithic period dentition from the southern Levant, and a large sample from the Late Hellenistic through Early Byzantine periods from the site of En-Gedi in Israel. The data were gathered using the adult dental morphology standards of the Arizona State University Dental Anthropology System, which enables highly replicable and precise observation. Descriptive, univariate, and multivariate analyses are used to characterize dental samples and compare degrees of phenetic similarity between them.

The results of this study confirm proposed dental continuity among post-Neolithic Nubians. Moreover, there is no support for population continuity between the late Pleistocene and post-Neolithic Nubians. Also, the results suggest that the extra-regional sourcing for gene flow and/or migration into post-Pleistocene Nubia may be extended as far north as the southern Levant, perhaps beginning as early as 12,800 y. BP.

Crown formation times of human permanent anterior teeth. H.M. LIVERSIDGE, Department of Pediatric Dentistry, The Royal London Hospital, QMW College, University of London, England.

One gap in the knowledge of human dental growth standards is crown fractions of anterior permanent teeth during the first few years of life. The limited knowledge available is based on an autopsy study of few individuals of dubious health status. Radiographic studies omit anterior teeth due to small jaws and unco-operative children.

The aim of this study is to document stages of crown formation for permanent incisors and canines. The material is C18th and C19th coffin buried collection from Spitalfields in London, where 50 individuals have recorded age-at-death (range 0 to 5.4 years). Developing teeth were dissected and tooth length measured. Fractions of crown formed were calculated from total crown height of unworn completed teeth from this population. Data for incisors and canine are presented as age of C1/4,

C1/2, C3/4 formed as well as radiographic and true crown complete. Median age for C1/2 of the upper central incisor was 1.34 years (N=16) and for canines was 2.52 years (N=34). Approximal root was visible on the lower central incisors between ages 3.00 and 4.50 years before true crown completion. Only two individuals had true crown complete of both lower incisors: aged 4.54 and 5.40 years. Further analysis of crown growth relative to M1 is presented including data from 56 unaged specimens from this collection.

These results provide a better objective estimate of crown fractions and doubles the sample size of previous standards of anterior tooth formation in early childhood.

Variation and temporal trends in the mandibles and dentition of *Australopithecus afarensis*. C. A. LOCKWOOD, W. H. KIMBEL, and D. C. JOHANSON, Institute of Human Origins and Department of Anthropology, ASU, Tempe, AZ 85287-4101.

The Pliocene hominin samples from Hadar and Laetoli are thought to represent one species, *Australopithecus afarensis*, with high levels of skeletal sexual dimorphism. The absence of extreme postcanine tooth size variation in the pooled Hadar/Laetoli sample has been cited in support of this interpretation. Significant additions to the Hadar sample during the 1990s invite re-examination of variation in the large samples of mandibles and teeth. Because this species spans at least 700 Kyr, it offers a rare opportunity to study the temporal component of variation in a hominin fossil sample.

We analyze coefficients of variation (CVs) for crown lengths and breadths at each postcanine tooth position (P3-M2; upper and lower), as well as mandible corpus height and breadth at the M1 level. Using bootstrapping methodology, overall variation in the fossil sample is compared to that of single populations of extant hominoid species, first using the pooled Hadar+Laetoli sample and then the Hadar sample alone. Nonparametric rank correlation methods are used to test for temporal trends in each measurement.

For the pooled-site sample, CVs for 8 of 16 dental measurements significantly exceed those of the chimpanzee sample; this number dropped to 4 of 16 for gorillas and to only 1 of 16 for orangs. Only the lower P4 length CV was more variable in *A. afarensis* than in all hominoid samples. Mandible corpus size variation exceeds that of chimpanzees but not gorillas or orangutans. For both mandibles and dentition, results were similar for the pooled-site sample and for the Hadar sample alone.

However, the total variation masks possibly important temporal trends. Lower P3 length shows a statistically significant decrease through time, driven by the difference between Laetoli and Hadar. Mandibular corpus size and upper M3 breadth and length increase through time, but these trends are apparent within the Hadar Formation and not simply between sites. No vectored change in mandible corpus shape accompanies the increase in corpus size over time. These results show that variation within *A. afarensis*, although consistent, on the whole, with one species, is a complex mixture of differences between sites as well as variation through time at Hadar.

DNA marker analysis for evidence of European contributions to Native American gene pools before and after Columbus. J.C. Long, M. Urbanek, F.C. Romero, D. Goldman, Laboratory of Neurogenetics, NIAAA, National Institutes of Health, Bethesda, MD 20892-8110.

The preponderance of anthropological evidence supports the inference that American Indians are the descendants of Asiatic people who migrated across the Bering land bridge in the late Pleistocene. More recent American Indian heritage owes to European admixture occurring in the last 500 years. Remarkably, an ancient skeleton found in the state of Washington has European-like features, suggesting that there may have been non-Asian components to the earliest American Indian gene pools. The purpose of this study is to analyze the genetic structure of contemporary American Indian populations for recent and ancient European ancestry.

Allele frequencies were estimated for 28 highly polymorphic dinucleotide repeat loci for 14 populations: 12 Native American populations (representing Alaska, the Plains, and the Southwest), 1 European population (Swedes) and 1 Asian Population (Chinese). All laboratory analyses were performed using standard methods including multiplex electrophoresis on an ABI 373A DNA sequencer (Foster City, CA) following PCR amplification with fluorescent dye-labeled primers. Statistical analyses were performed using the maximum likelihood test for admixture in evolutionary trees developed by Cavalli-Sforza and Piazza (1975, *Theor. Pop. Biol.* 8:127-165).

We tested variations on a tree that nested American Indians and Asians before joining both groups with Europeans. Allowing European admixture to the terminal American Indian population(s) improved the fit of the tree. This is consistent with post-Columbian events. However, allowing American Indian populations to be formed as a European/Asian admixture did not improve the fit of the tree. This does not support skeletal evidence for an early European contribution to American Indians.

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Sexual dimorphism in the long bones from a Spanish Medieval ossuary I. LOPEZ-BUEIS, Dept. Anthropology, U. of California, Santa Barbara, CA 93106, and G. TRANCHO, Dept. Animal Biology I (Anthropology), Universidad Complutense de Madrid, 28040 Madrid, Spain.

The assessment of sex from osseous remains constitute one of the first steps in the analysis of past human populations. In fact, sex differences are so important that at statistical level they are considered as independent groups. The problem arises from the lack of accuracy when sexing isolated bones, which can provoke an important loss of information about the population considered.

We have studied the possibility of determining sex from the long bones of the ossuary of Wamba (XV-XVII

Centuries, Valladolid, Spain). The adult sample consists of 501 humera, 173 radii, 185 ulnae, 635 femora and 538 tibiae. Each bone was assigned sex through several qualitative features. The sexual dimorphism of the samples was analyzed at uni- and multivariate levels. The variables showing maximum differences between sexes were those related to the diaphysis. The principal component analysis showed two different patterns, one for humerus and femur and the other for lower arm and tibia. Due to the good preservation of the samples, a total of 80 quantitative variables were taken and they were subjected to SPSS discriminant function analysis. The average percentages of correspondence between the assigned sex using qualitative criteria and the discriminant functions varied from 89% for the femur to 91.3% for the tibia. Most of the dimensions which offered the highest percentage of correspondence for each bone were those defining the epiphyses. We also applied several discriminant functions found in the literature from American and European populations. The functions are highly population specific and we found that the percentage of correspondence using European equations was higher than with American functions. Even with this limitation, the results point out that there is a number of variables that show a high applicability in Wamba as well as in the rest of populations which have these kind of studies. Most of these variables are referred to epiphysial dimensions.

Gonial eversion: It isn't sex. S. R. LOTH, Anatomy (Medicine), University of Pretoria, 0001, South Africa, and M. HENNEBERG, Anatomical Sciences, University of Adelaide, S. Australia 5005

Traditionally, gonial eversion has been used as a sex indicator in the mandible. However, the sexing accuracy of this single trait has not been quantified on a large, diverse sample. Thus, the purpose of this paper is to investigate the development and population specificity of gonial eversion, and determine its sexing accuracy on a multipopulation sample of 610 known sex individuals from birth to over 90 years. Each mandible was assessed as having clearly expressed bilateral eversion, no eversion, or "indeterminate" in cases with unilateral eversion, or only "fringes" at the gonial base. Results indicated that while gonial eversion is evident at birth, sex diagnosis never even reaches the random level of 50%. For ages 0-5 years sexing accuracy was 37%, for 6-19, 28.5%, and ages 20 and older, 49.7%. In all groups, females were more accurately discerned than males. Chi squared tests revealed significant population differences between African blacks (31%) and all other groups: American whites (39%) and blacks (24%), and Amerindians (25%). While a higher percentage of the everted specimens were male (79%), the fact that only 31% of adults are everted severely limits sexing potential.

Several findings explain the ineffectiveness of gonial eversion as a sex predictor. The most obvious is that over 2/3 of adults are *not* bilaterally everted. This also explains why female accuracy is consistently higher than

that of males. Significant population differences in the frequency of eversion and its presence at birth suggest a hereditary basis. The strongest evidence against the misconception that eversion reflects robusticity are the results for Palaeoamerinds. Of these, the most robust bones in the sample, just 25% were everted. This is also supported by the fact that the least robust group (whites) had the highest level (39%). In conclusion, the present findings suggest that eversion is only expressed in those who have inherited the genes for it, regardless of sex and robusticity. The greater average muscle mass and strength in males does not create eversion, but simply exaggerates it in susceptible people.

Craniofacial change in the mature and elderly: a three-dimensional comparison of sexual dimorphism in aging. A.M. LUBENSKY, J.T. RICHTSMIEIER, Johns Hopkins University School of Medicine, Baltimore, MD 21205

It is a common misconception that adulthood is defined by the completion of bony growth or change. In the craniofacial complex, several studies have demonstrated significant morphological change long after "maturation." Varying and problematic methods, however, have precluded any general conclusions regarding the specific nature of craniofacial change in late adulthood.

Previous studies have predominantly used cephalometric (2-dimensional x-ray) methods or compared a limited number of traditional craniometric measurements. In addition, scientists have traditionally concentrated on the maxillo-mandibular area, thus little information is known about other important craniofacial regions. In this analysis, Euclidean Distance Matrix Analysis (EDMA), a registration-free method, is used to assess differences between all linear distances calculated among 98 biologically significant landmarks in three dimensions.

Using a 3-space digitizer, three-dimensional coordinates of craniofacial landmarks were collected from 54 individuals of known age and sex from the Terry Collection, Smithsonian Institution. Specimens were chosen to fit into two chosen age groups: 40-45yrs. old and 70-75yrs. old. Males and females were analyzed separately. Skulls and mandibles were digitized, and internal cranial landmarks were included when available. Within sex comparisons of craniofacial and mandibular regions were made between the two age groups. Male and female "growth trajectories" were also compared. A p-value less than .05 was considered statistically significant.

Results indicate that in late adulthood, both males and females grow significantly and along similar trajectories in the superior maxilla and basioccipital regions. Conversely, males and females differ in the amount of growth in the palatal and nasal regions, in vault expansion, and in the stability of landmark points related to neurovascular bundles and neurological structures. Males show many significant changes in both external and internal cranial base morphology with age. This is contra previous studies that have held the cranial base as constant, and indicates potential sexual dimorphism in cranial base stability.

Notably, cranial dimensions never decreased significantly over time in either the male or female sample. However, in comparison to the males, females display many more distances that decreased with advanced age, and show significantly decreased distances in the mandible. Postmenopausal decreases in estrogen and increased risk of osteoporosis may play a role in this difference.

Complex enamel structure in Primates. M.C. MAAS, Dept. Anthropology & Laboratory of Vertebrate Paleontology, University of Texas, Austin TX 74712 and Dept. Anatomy, NEOUCOM, Rootstown OH 44272

Prismatic enamel is characteristic of most mammal teeth but some groups have evolved complex enamel arrangements that include a variety of enamel types. One specialized enamel type is prism decussation and its optical manifestation, Hunter-Schreger bands (HSB). HSB strengthen enamel by inhibiting crack propagation. This study examines enamel complexity and the distribution of enamel types among living and fossil primates.

The sample consists of molars from 38 primate species: 12 extant prosimians (11 strepsirhines and *Tarsius*), 15 fossil prosimians (North American and European adapids and omomyids), six extant anthropoids (five New World monkeys and *Macaca*), and five fossil anthropoids from the Fayum. Teeth were sectioned, polished, lightly etched with acid, and examined with by light microscopy and scanning electron microscopy (SEM).

Among extant small bodied species (average body weight <1500 g) the arrangement of enamel types within a tooth consists of radial (non-decussating) prismatic enamel and a variably thin outer layer of nonprismatic enamel. Among extant larger species (> 1500 g) HSB predominate while smaller amounts of radial and nonprismatic enamel are present. However, the size-enamel type relationship is complicated by differences in the proportions of enamel types and by variations within each enamel type. Thus, radial prisms may extend straight from the EDJ to the outer tooth surface or may have an undulating course. Likewise, HSB may be weak (poorly defined bands with gradual transitions between zones) or strong (well-defined bands with abrupt transition between zones). Fossil species show the same size-related distribution of enamel types as extant species and similar variation within each enamel type, though no Eocene or Oligocene species had strong HSB. The significance of enamel complexity in primates is explored by analysis of morphological (enamel), ecological (body size and diet), and phylogenetic (taxonomic distance) variables for living species using matrix correlation analysis.

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Locomotion-related iliac trabecular patterns in fossil and extant primates. R. MACCHIARELLI and L. BONDIOLI, National Prehistoric Ethnographic "L. Pigorini" Museum, Rome, Italy; L. ROOK, Earth Sciences Department and Paleontological Museum, University of Florence, Italy.

The iliac cancellous network shows substantial locomotion-related architectural differences between humans, apes, and cercopithecoids. The human pattern is characterized by a distinctive ilioischial bundle, a strong and undivided sacropubic bundle, and a diagonal full crossing over the acetabulum between these two bundles. In *Pan*, the inner bundles of the iliac blade do not form a "St. Andrews-like" cross as seen in humans, but only partially flow into a higher density confluence of trabeculae. In *Papio*, the whole

cancellous network appears much less structured and anisotropic than in great apes and humans.

Functional analysis of fossil trabecular bone is usually limited by distortion and mineralization. In order to enhance the strength of qualitative and quantitative analyses, we investigated the hip bone trabecular structure of fossil and extant primates by means of advanced digital image processing of calibrated radiographs. The sample includes: extant humans (N=196), hominoids (N=23), Old and New World monkeys (N=16), and prosimians (N=2); early and late fossil *Homo* (N=10), South African australopithecines (N=8; in Macchiarelli *et al.* 1996, Galichon 1997), *Oreopithecus*, *Pliopithecus*, and early Pleistocene *Macaca*.

Results show that the application of digital technology allows the extraction of reliable structural information for the reconstruction of fossil locomotor behaviours. Supported by the Italian National Research Council (CT 15, "Cultural Heritage" Project).

Cerebellar smarts; the expansion of the lateral lobes in primate evolution. C.E. MACLEOD, J.K. RILLING, and T.R. INSEL, Dept. of Archaeology, Simon Fraser University, Burnaby, BC V5A 1S6; Dept. of Anthropology, and Yerkes Regional Primate Center, Emory University, Atlanta, GA 30322.

Recent evidence indicates a role for the lateral lobes in human cognition, but no comprehensive, systematic data exist chronicling their expansion in primates. This is, in part, due to morphometric difficulties, yet a rough idea of lateral lobe expansion is necessary to those tracing the evolution of the cerebellum through a comparative model and endocasts.

The medial aspect of the cerebellum (vermis) was measured in 46 MR scans of human and nonhuman primates from the Yerkes Primate Center, including 20 Greater and Lesser Apes, 20 Old and New World Monkeys, and 6 humans, representing 11 species in total. The vermis was measured in the sagittal plane using Easy Vision software, and cross-checked on the horizontal and frontal planes for a three-dimensional view. The boundaries of the medial cerebellum were determined by the orientation of the folia, which change from perpendicular in the vermis to horizontal in the hemispheres.

Both absolute size and linear regression comparing lateral to medial cerebellum show a dramatic expansion of the lateral lobes in human evolution. Yet this pattern is shared with the apes, as shown by a marked shift in proportion of lateral to medial cerebellum between apes and baboon, rhesus, mangabey and capuchin monkeys. The lateral lobes of hominoids are about eight times larger than expected in a monkey of equivalent medial

cerebellum size. Within allometric constraints there are taxon differences in lateral lobe size, which may be due to ecological, locomotory or behavioural variables. The allometric pattern and the degree of variation shown by this comparative model provide parameters for the interpretation of cerebellar expansion in hominid evolution.

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The use of archives in the study of microevolution: the case of Escazú, Costa Rica. L. MADRIGAL, Department of Anthropology, University of South Florida, Tampa, FL 33620.

A primary focus of biological anthropological research is the study of microevolution cross-culturally. Archives allow researchers to study microevolution diachronically in populations from previous centuries, and cross-culturally in groups throughout the world. With archival research, biological anthropologists are in a position to study microevolution by analyzing mortality, fertility, marriage and migration, all at once. This paper summarizes an on-going research project in Escazú, Costa Rica, a population whose microevolution has been researched from these various perspectives.

Since its foundation in 1799, the Parish has kept excellent vital event certificates. The data discussed here include the death, birth and marriage records from 1799 through 1899.

From a microevolutionary perspective, this is a population that was established by a few core families, but benefited from immigration in the early part of the 1800's. The marriage certificates indicate that there was no preferential mating among any families, and that inbreeding was moderate. Natural selection appears to have acted strongly through mortality, by impacting childhood mortality in the form of diarrheal diseases and epidemics. Diarrheal diseases had a strongly seasonal distribution, being highest during the early months of the rainy season. In contrast, births were not seasonally distributed, probably as a result of a yearlong available food supply. Moreover, marriages were equally distributed through the year.

It can be concluded that by having a moderate level of within family inbreeding, and a virtual absence of a Wahlund effect, the Escazú population structure presented few barriers to gene flow. Natural selection probably acted strongly through differential mortality, and less so through differential fertility.

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Genetic and environmental contributions to hematological variation in pedigreed baboons. M.C. MAHANEY, S.A. CZERWINSKI, D.E. NEWMAN, and C.L. SNIDER. Southwest Foundation for Biomedical Research, San Antonio, Texas.

Elucidation of the genetic and environmental influences on normal variation in hematological variables can provide useful insights into homeostatic mechanisms that may be critical to survival, reproduction, and evolution. As part of a

five-year study of hemostasis and thrombosis in nonhuman primates, we assessed the genetic basis of six hematological phenotypes in 515 captive baboons (*Papio hamadryas anubis*, *P.h. cynocephalus*, and their hybrids) from four extended pedigrees. Data were obtained from freshly drawn 5 mL blood samples by means of standard clinical assays for the following quantitative variables: the numbers of red blood cells (RBC), white blood cells (WBC) and platelets (PLT); hematocrit (HCT); and mean volumes of circulating blood cells (MCV) and platelets (MPV). For each phenotype, maximum likelihood variance components methods were used to estimate simultaneously the mean; mean effects of sex, age-by-sex, body weight, percent *P.h. cynocephalus* admixture, and number or volume of other blood cells; the residual phenotypic standard deviation; plus the proportion of the residual phenotypic variance due to the additive effects of genes (heritability or h^2) and random environmental factors. Genes contributed significantly to the residual phenotypic variance in all six traits ($p < 0.0001$): for RBC, $h^2 = 0.46$; for WBC, $h^2 = 0.38$; for PLT, $h^2 = 0.22$; for HCT, $h^2 = 0.35$; for MCV, $h^2 = 0.44$; and for MPV, $h^2 = 0.62$. Significant covariate effects were estimated for sex ($p < 0.0001$; for MPV and PLT), age-by-sex ($p < 0.01$; HCT, MCV, RBC and WBC), percent *P.h. cynocephalus* admixture ($p < 0.0001$; HCT and RBC), and PLT and MPV ($p < 0.0001$; for MPV and PLT, respectively). These results demonstrate that environmentally labile traits, such as these hematological indicators, can have significant genetic determinants. Because power to detect linkage between a trait and a chromosomal region is a function of the genetic signal to noise ratio, these results make these phenotypes excellent candidates for genome scans using our recently constructed baboon gene map. Given the demonstrated genetic and physiological similarity of baboons to humans, continued statistical genetic study of these traits will have implications for the biology of hematological variation in our own species as well.

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New evidence on Predynastic burial methods in Egypt. MAISH, A.J. University of Toronto and TUCKER, T.L. Ohio State University.

New cemetery excavations at Adaima, KHD, and Hierakonpolis in Egypt are revealing some new burial patterns and raising some new questions about Predynastic burial methods. Findings from these cemeteries indicate that the burial practices of the Predynastic should be reconsidered from a chronological and regional perspective.

Savage (1998) has recently published new radiocarbon dates from Naga ed-Der and recalibrated older dates from previous excavations at other sites using an updated scale. While this most recent information only helps to fill in the chronological gaps of the Predynastic period, it does provide a platform in which to begin constructing hypotheses about Predynastic burial methodology. Using these radiocarbon dates and dividing the cemeteries into Upper and Lower Egypt and some smaller districts it is possible to start delineating patterns.

Some of the most important finds being uncovered have to do with the process of mummification and demography. The dates for early forms of mummification may need to be moved up to c. 3500 BC. There also

appears to be differential treatment for males and females which may be helpful for determining the sex of the individual. Hypotheses relating to cemetery use and development will also be presented in the context of the new finds.

Estimates of cranial capacity and encephalization in *Proconsul* and *Turkanapithecus*. J. MANSEER and T. HARRISON, Anthropology, New York University, New York, NY, 10003

Estimates of cranial capacity among fossil catarrhines from the Miocene of East Africa have been limited by the fragmentary nature of the material. The only specimen for which an estimate is available is the distorted and incomplete skull of *Proconsul heseloni* (KNM-RU 7290) from Rusinga Island, Kenya. Walker *et al.* (1983), using the length of the midline arc of the endocranium as a surrogate, were able to estimate the cranial capacity at 167.3 cm³. From this, the authors deduced that *Proconsul* was more encephalized than modern monkeys of comparable size, a specialization that was purported to associate it with the great apes. Subsequent workers have used increased encephalization as an important synapomorphy linking *Proconsul* with the extant hominoids.

Preliminary work has demonstrated that foramen magnum size can be used to obtain reliable estimates of cranial capacity in fossil catarrhines. In the present study, a regression of log cranial capacity (cm³) against log foramen magnum area (mm²), based on extant anthropoids, yields a high correlation coefficient ($r^2 = 0.97$; $y = 1.211x - 1.84$). Fortunately, the foramen magnum in RU 7290 is complete enough to estimate its dimensions with some degree of accuracy, and this permits an independent assessment of cranial capacity. Based on these data, *P. heseloni* has a predicted brain size of only 130.3 cm³. Using 10.9 kg as a reasonable average body weight for female individuals, *P. heseloni* is placed only slightly above a regression line of log cranial capacity (cm³) against log body weight (kg) for extant anthropoids. Using various measures of encephalization in primates it can be shown that *Proconsul* lies close to the mean for anthropoid primates, and that there is no basis for supporting the contention that cranial capacity serves to link it with extant hominoids. Given the range of diversity seen in modern anthropoid clades, degree of encephalization has limited utility as a character in phylogenetic analysis, and appears to be much more closely correlated with behavioral or ecological attributes. The level of encephalization indicates, for example, that *Proconsul* was an unspecialized frugivore; an inference supported by its cranio-dental anatomy.

The foramen magnum of *Turkanapithecus kalakolensis* (KNM-WK 16950) from Kalodirr in Kenya is sufficiently well-preserved to employ the same method. This allows direct comparison of the degree of encephalization in two contemporary species. The size of the foramen magnum in *Turkanapithecus* gives a projected cranial capacity of 84.3 cm³. The skull and associated postcranial material belong to a male, somewhat smaller than female individuals of *P. heseloni*, with an estimated body weight of ~10 kg. The degree of encephalization in *Turkanapithecus* is comparable to modern folivorous anthropoids, a finding that is commensurate with its specialized cranio-dental morphology.

Infant diseases in Early Colonial Times in Mexico: the Spanish population from San Jeronimo, Mexico City. J. MANSILLA, Dirección Antropología Física. Instituto Nacional de Antropología e Historia, México D.F. 11560 and M. SCHULTZ, Center of Anatomy, University of Göttingen, Germany.

During Colonial Times, the Spaniards traditionally buried their dead inside their churches. In San

Jeronimo's church in Mexico City, a crypt was found underneath the presbytery during excavations in 1976. Most of the skeletal material recovered from this site belongs to disarticulated fetuses, newborns and early infants. A total of 18,222 bones representing at least 592 subadults were examined.

In this study, analysis was carried out by macroscopic, magnifying glass and radiological techniques on the pathological lesions of the bones. From the pathological bones, a selection was examined using light and scanning-electron microscopic techniques.

In order to establish the social class of these individuals, parochial records were consulted from the first books (1671) until 1800. Historical and environmental data were also integrated to establish the way of life of the inhabitants of the capital of New Spain.

The early death of these children and fetuses, combined with various skeletal stress markers, such as cribra orbitalia, transverse linear enamel hypoplasia, Harris lines and periosteal reactions suggest a generally poor standard of health and a hard life for these Colonial inhabitants of Mexico City, despite the fact that they generally came from higher social classes.

Social scratch, a newly reported custom in social grooming by the chimpanzees (*Pan troglodytes schweinfurthii*) of Mahale Mountains National Park, Tanzania. L.F. MARCHANT¹, W.C. MCGREW^{1,2}, and M. NAKAMURA³, ¹Anthropology, ²Zoology, Miami University, Oxford, OH 45056, ³Zoology, Kyoto University, Kyoto, 606-8502, Japan.

Chimpanzee unit-groups show unique patterns of behavior that reflect cultural traditions. The chimpanzees of the Mahale Mountains National Park, Tanzania were among the first populations to provide evidence of such customs in the form of the grooming hand-clasp (McGrew & Tutin, 1978). Here we report another pattern, Social Scratch (SS), that occurs in the context of Social Groom (SG). SS consists of scratching another individual using the same motor pattern as Self-Scratch.

Using focal subject sampling to study social grooming, the chimpanzees of M group (N=53) were observed by MN from July, 1996 to May, 1997. LFM and WCM also used focal subject sampling to study laterality of hand function for 44 members of M group from September through December, 1996. Combining data sets we identified 31 individuals in the community who showed this behavior. Thus, it is a customary behavioral pattern for this unit-group (McGrew & Marchant, 1997). Social Scratch was positively correlated with Social Groom but not with Self-Scratch; individuals who groomed others often, did more SS, and individuals who were groomed frequently, received more SS. Adult and adolescent males received more SS than expected per grooming hour, and among adults, higher-ranking males received more SS, suggesting that SS may be related to

social tension. SS was usually directed to the dorsum, however, lactating females included other body-parts when doing SS to infants.

Thus far, no behavioral equivalent to SS has been reported for other long-studied chimpanzee populations. For example, after more than 38 years of observation, SS has not been noted at Gombe National Park, located only 170 km. north of Mahale.

LFM and WCM supported by a grant from the Philip and Elaine Hampton Fund, Miami University.

Comparison of landmarks among *Papio* skulls, with extension of Procrustes methods to ridge curves. L.F. MARCUS^{1,2,4,6}, S.R. FROST^{2,6}, F. BOOKSTEIN³, D. REDDY⁴, E. DELSON^{2,4,6}, ¹Queens College, ²City University of New York Graduate School, ³Institute of Gerontology, University of Michigan, ⁴American Museum of Natural History, ⁵Lehman College, ⁶New York Consortium in Evolutionary Primatology (NYCEP).

Forty five three dimensional (3D) craniometric landmarks, as well as 15 facial ridge curves have been recorded on 44 *Papio hamadryas anubis* and 27 *P. h. ursinus* skulls using a Microscribe 3D digitizer. Both males and females are represented for each sub-species. Equidistant points were sampled along the ridge curves and examined using a new hybrid technique combining Procrustes and thin-plate spline analyses. The landmarks were aligned in Kendall's tangent space using Rohlf's tpsSmall program. Centroid size was computed in SAS. The sexes and sub-species differ in centroid size. There is no significant interaction between sex and sub-species. For the landmark data there are significant differences in shape between sexes and sub-species. There is a small amount of interaction in shape. Shape differences are visualized using the principal components option in the GRF-ND software of Slice. Two dimensional projections of the data allow better description of shape differences and allometric relationships to centroid size using the tps series of programs. Bookstein's new method of thin plate spline relaxation and Procrustes analysis of ridge curves allows comparison of features using powerful multivariate tools for inferring sex and sub-species differences. Discriminant analysis using ridge features of extant papionins permits tentative identification of fossil facial fragments. Supported by NSF DIR 91-13609 (NYCEP) and grants from the PSC-CUNY Faculty Research Award Program

Enamel microdefects and childhood morbidity among historic African-Americans. M.K. MARKS and D.C. BENEDIX, Department of Anthropology, University of Tennessee, Knoxville, TN 37996-0720

Light and electron microscopy of systemic disturbance in tooth enamel have been structurally and chronologically well-documented for clinical, epidemiological, archaeological and historic samples.

While the relationship between enamel hypoplastic events and pathological osseous lesions has been successfully employed in historic African-American bioarchaeology, the utilization of Wilson band, e.g., abnormal striae of Retzius, frequencies provides a more sensitive monitor of childhood vulnerability among these historically-obscure 19th and early 20th century samples.

Even though the First African Baptist Church (FABC) (1823-1842), Cypress Grove II (1849-1929) and Cedar Grove (1890-1927) groups represent a temporally, geographically and culturally diverse profile of the historic African-American experience, these developmental dental data can help establish fact from fiction regarding quality of life, nutrition and disease status. Wilson band frequencies display a collective female peak age of 2.5-3.5 years with males evidencing a later peak between 3.5-4.5 years. Female susceptibility, given their greater innumeration at all sites, may explain why the sample is weighted towards females between 30-40 years. This may explain the differential peak age of stress. Other inter- and intra-group age and sex comparisons indicate, not unexpectedly, similarities given like environmental constraints.

As with prehistoric examples, children display a greater frequency of Wilson bands than adults. Overall, enamel defect-inducing etiologies were greater among the Cedar Grove inhabitants during childhood than either Cypress Grove or FABC. Regardless of site specifics, such morbidity data clearly indicate a consistent health pattern not unlike the long-standing social, economic and political marginalization and isolation suffered by these communities.

The meaning of emptiness: Pneumatization patterns of great ape paranasal sinuses via CT imaging. S. MARQUEZ, E. DELSON, A. SILVERS, W. LAWSON, and J.T. LAITMAN. Depts. of Cell Biology/Anatomy, Radiology, and Otolaryngology Mount Sinai School of Medicine, NY, NY 10029, Anthropology, Lehman College, NY, NY 10468

Although the processes of skull pneumatization are not fully understood, the presence and extent to which these air-containing spaces invade the bony elements of the cranium has been important in hominoid phylogenetic analysis. Extant humans exhibit four paranasal sinuses: maxillary, frontal, and sphenoid sinuses and a collection of 2-8 distinct cells on each side comprising the ethmoid. This study employed CT imaging to chart the growth, development, and variation in paranasal sinus morphology of great apes by metric and non-metric assessments.

An ontogenetic series of dry crania of the great apes (*Pan troglodytes* n=5, *Gorilla gorilla* n=5, *Pongo pygmaeus* n=5) representing both sexes from the Anthropology and Mammalogy Collections of the American Museum of Natural History was studied. Age stages were based on dental eruption patterns. GE HiSpeed Advantage CT scanners were used to describe and quantify sinus morphology based on multiplanar reformatting and 3D reconstructions using the GE Advantage Windows 1.1 program. Among the taxa studied, frontal and sphenoid sinuses (SS) were found only in the African apes. In these, sphenoidal development is extensive, involving pneumatization of the pterygoid plates and greater wing. A maxillary sinus (MS) was found to be present in all species. An invasive pneumatization of the hard palate by the MS was found to

be present only in *Pan*. The MS in the gorilla is encroached by a unique developmental enlargement of the lacrimal canal which occupies 41% of its volume. The ethmoid sinus (ES) appeared well developed in adults of both gorilla and chimp, with 1-2 and 4-5 air cells on each side, respectively. Contrary to previous studies which noted the absence of ES in orangutans, we found two small ethmoid air cells in an adult. These data suggest that an understanding of PNS morphology in living apes may serve as a valuable tool for phylogenetic studies. For example, the presence of small ethmoids in orangs may indicate an ancestral condition for the great ape and human clade. Indeed, the higher number of ethmoid air cells in *Pan* and *Homo* might be a synapomorphy of these taxa, thus supporting their close phylogenetic affinities. Increased understanding of both PNS basic biology and expression in apes and humans will offer insight into the evolution of this crucial region in fossil hominids.

Paleodemography and paleopathology of a Bronze Age skeletal population from Tell Abraq, United Arab Emirates. D.L. MARTIN, P.K. STONE, N. PARKER, Natural Science, Hampshire College, Amherst, MA 01002, M.M. MARGOLIS, Anthropology, FLC, Durango, CO 81301, F. HARROD and V.R. PEREZ, Anthropology, U. of Massachusetts, Amherst, MA 01002.

Excavation of a large Umm an-Nar tomb at Tell Abraq revealed a great quantity of disarticulated and commingled human remains representing at least 250 individuals. The tomb was used over a 300-year period and the remains are in relatively good condition although most are partially broken. All age categories are well represented, from fetal and newborn remains to individuals aged sixty and older. The demographic profile by age categories suggests a well represented Neolithic population with approximately half of the individuals aged below 18.

Non-specific periosteal reactions resulting from transmissible infections are found in approximately 50% of the long bones and osteoarthritis is pronounced and severe in all individuals aged over 30. Analysis of the remains for signs of dietary stress revealed a well-nourished population that likely subsisted on a diet of fish and shellfish, camel and goat, barley and wheat, and fruits such as dates. Analysis of the dentition demonstrated dental wear and loss with caries and abscessing.

Some unique features of this skeletal population include an extreme range of variability in size and robusticity among the long bones in particular. Individuals range from small and gracile to large and hyper-robust. Epigenetic analysis of dental traits suggests a genetically homogeneous population, and these size differences may relate to gender, status or occupationally-related bone changes within the population. Because so little is known regarding the Bronze Age in Arabia, this skeletal population offers a rare look into biology and cultural practices.

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Variation in inhibin, and activin levels in baboons. LJ MARTIN^{1,2}, MH CRAWFORD², AG COMUZZIE¹.

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Inhibin and activin are proteins that regulate reproductive hormones and growth in gonadal and non-gonadal tissues. Although these proteins were initially identified because of their role as FSH regulators, recent research has implicated these proteins in several different diseases including cancer and infertility. Inhibin and activin levels have been assayed in humans and rhesus monkeys; however, these proteins have not been assayed in other primate species. Although levels of these proteins have been studied extensively in individuals, little research has yet examined their variation at the familial or population level. Therefore, the purpose of the present study was twofold: 1) to assess the feasibility of assaying inhibin and activin in baboons, and 2) to begin to characterize the extent of variation in these important reproductive proteins. The data for this study were obtained from 60 animals (42 females, 18 males) from the baboon (*Papio hamadryas*) colony at the Southwest Foundation for Biomedical Research. Activin A and inhibin B levels were assayed from previously frozen serum samples by ELISA using commercially available kits (Serotec Ltd.) and following the same assay protocol used for human samples. These assays yielded intra-assay CVs of 10.9% and 10.8% for inhibin B and activin A respectively. For females mean inhibin B levels were 130.66 ± 9.31 ng/ml with a standard deviation of 60.30 ± 5.51 with activin A levels having a mean level of 0.28 ± 0.02 with a standard deviation of 0.13 ± 0.01 . For males mean inhibin B levels were 682.00 ± 46.79 ng/ml with a standard deviation of 198.52 ± 18.12 with activin A levels having a mean level of 0.25 ± 0.02 with a standard deviation of 0.08 ± 0.01 . Inhibin B levels were significantly different in males and females ($p < 0.001$). These preliminary findings suggest that these proteins can be measured in baboons, and that there is sufficient variation among individuals to warrant the undertaking of additional quantitative genetic analyses. Future work will focus on expanding our sampling to include the approximately 700 animals for which we now have a 10cM genetic map and to conduct a genome scan for genes influencing the expression of these critical reproductive hormones.

New generic designations for the African galagos based on morphological and molecular data. J.C. MASTERS, Natal Museum, Pietermaritzburg 3200, South Africa, and M. DELPERO, Dipartimento di Biologia Animale, Università di Torino, 10123 Torino, Italy.

The systematic classification of the African galagos is controversial at all levels. We focus here on the debate concerning how many and which genera should be distinguished.

Data from mitochondrial sequences, allozymes and highly repeated DNAs indicate that the galago genera currently recognized do not have a phylogenetic basis. This is supported

by evidence from morphology and the fossil record. Whereas the taxa *alleni*, *demidoff* and *zanzibaricus* have been classified together as the genus *Galagoides*, our analyses indicate that this is not a monophyletic group: *alleni* is sister to the greater galagos, which are often classified under *Otolemur*; *demidoff* and *zanzibaricus* both diverged early in the galago radiation, but are not sister taxa. *Galagoides* should be reserved for *demidoff* and its allies, while *zanzibaricus* needs its own genus.

The alternative is to retain all galago species under the single rubric *Galago*. This option has several merits, particularly nomenclatural stability. However, it affords no information regarding relationships within the group, and could become unwieldy with the growing number of cryptic species being identified. We propose a new generic scheme that best reflects the group's evolutionary history.

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Cranial dimorphism in *Cebus capucinus*. T.J. MASTERSON, Department of Biology, James Madison University, Harrisonburg, VA 22807.

Cranial sexual dimorphism in *Cebus capucinus* is investigated by means of univariate and bivariate statistics in 23 linear dimensions. Three subspecies, *C. c. capucinus*, *C. c. imitator*, and *C. c. limitaneus*, each with approximately equal sample sizes are used to test three hypotheses at the subspecific and species taxonomic levels. Subspecific designation was assigned based on location of capture and cross-checked with the literature (Rylands et al., 1995; and references within).

Results from both the unpaired t-tests and indices of cranial dimorphism corroborate the hypothesis that males of each subspecies possess significantly larger means in the majority of the variables (18 of 23). None of the subspecies are significantly dimorphic in orbital height and postorbital constriction. Subspecific differences exist in only three variables. *Cebus c. capucinus* is the only subspecies that does not possess a significant sexual difference in orbital width. Only *C. c. imitator* possesses a significant sexual difference in vault height; likewise, only *C. c. limitaneus* possesses a significant sexual difference in neurocranial breadth.

Results from Greene's (1989) t-test confirm the prediction that no significant differences in the degree of sexual dimorphism are present among the three subspecies, except for one variable. *Cebus c. limitaneus* possesses a significantly larger degree of dimorphism in basioccipital length than both *C. c. capucinus* and *C. c. imitator*. This prediction is also corroborated by results of Konigsberg's (1991) multivariate test.

At the species level, bivariate growth allometries confirm that ontogenetic scaling is the primary growth pattern in the cranium of *C. capucinus*. The heterochronic process of time hypermorphosis is suggested to underlie this pattern. However, several departures from ontogenetic scaling are present. It seems that female *C. capucinus* possess

disproportionately wider neurocrania and more prognathism compared to males. Acceleration and neoteny are suggested to underlie these respective departures.

The underlying selective regime that best explains the observed morphological patterns of cranial variation in these three subspecies of *C. capucinus* is sexual selection.

Asynchrony of estrous swelling in Mahale chimpanzees.

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Recent studies suggest that synchrony of female sexual cycle occur such as menstrual synchrony in humans and synchrony of estrous swelling in chimpanzees. Whether females synchronize their sexual cycle is an interesting question to consider female reproductive strategy because either females may compete with each other for males when their estrous cycles synchronize or females may maximize the reproductive success of themselves when their estrous cycles are arranged uniformly. The purpose of this study was to investigate the synchrony of cycles in the wild chimpanzees by using long term data sets.

We analyzed the data of estrous cycle in 1981, 1991 and 1993 of wild chimpanzees (*Pan troglodytes*) lived in the Mahale Mountains National Park, Tanzania. Physiological estrus in chimpanzees is characterized by genital swelling ensuing from increasing levels of follicular estrogen. Copulations also occur in this period. Estrous cycles of 15, 8, 10 chimpanzees were observed respective years. Females' estrous states (maximal size or not) were recorded every day. The analysis factors were two: overlap of estrous days and that of possible fertilization days. The theoretical distribution of estrous rate was calculated by particular female estrous swelling length, and was compared with the data of particular estrous rate. The results showed females arranged their estrous swelling days uniformly. On the other hand, the possible fertilization days were neither synchrony nor asynchrony.

The palate of KNM-WT 17000: new data about its skeletal maturation ? B. MAUREILLE and J. BRAGA, UMR 5809 CNRS, Department of Anthropology, University Bordeaux I, Av. des Facultés, 33405 Talence cedex, FRANCE

KNM-WT 17000 is an adult cranium attributed to either *Australopithecus (Paranthropus) boisei* or *A. (P.) aethiopicus*. It was found in 2,5-Myr-old sediments west of Lake Turkana and evinces a very large and well-preserved facial skeleton and palate.

This study deals with non-metrical variants observed on the inferior aspect of the palate that may be related to skeletal maturation. Indeed, it was possible to score an uncommon combination of traits on the boundary between the maxillary and incisive (or premaxillary) bones. However, these traits remain difficult to interpret in terms of development even in extant humans.

On both sides, this adult specimen evinces scars of two structures which could be :

a) either the premaxillary suture and one interincisif sinus (the correct anatomical term that should be used for the endomesognathic suture) which has a more antero-medial location;

b) or two interincisif sinuses and the most medial part of the premaxillary suture.

From the expression and location of the corresponding features in young and adult extant humans, this latter unique combination seems to be the more pertinent. The existence of interincisif sinus on Pliocene hominids was never described before. Nevertheless, the existence of two interincisif sinuses was known only in the very young Neandertal child sample and is very rare in very young humans (1,5%, n = 321). Considering the ontogeny of the interincisif sinus in extant humans, the presence of two sinuses on this specimen could be a consequence of the development of their large permanent front teeth.

The effects of subsistence economy on the dental health of individuals from Spiro Mounds, Oklahoma. A. T. MAYES, University of Colorado, Boulder, Co. 80301

The Spiro Mounds of Southeastern Oklahoma is a ceremonial complex occupied from around AD 900-1450. The primary excavation of this complex was carried out by the Works Progress Administration (WPA) in the 1930's in order to save the mounds, the burials, and the artifacts from the destruction of pot hunters. It has been hypothesized that the individuals interred at the Spiro Mounds held elite status within their society, as shown by the extensive associated funerary objects. Within the literature there is some debate on the role of maize in the diet of Spiro Individuals.

The focus of this paper is the assessment of health status of a sample population from the Spiro Mounds as indicated by the dentition. This study group consisted of 51 individuals, 30 maxilla, 30 mandibles, with a total of 421 teeth.

This assessment indicated a generally healthy population in terms of dental status. Carious dentition was low in this sample (18%), with an equally low incidence of periodontal disease (24%). Childhood stress is indicated in the individuals from Spiro with 43% (n=22) having enamel hypoplasias. Occupational stress was not considerable as observed by the level of dental attrition among the Spiro sample. The highest incidence of tooth wear (24%) was at the level of moderate cusp removal.

The results indicate a population with good dental health. The level of oral health, despite predisposing

traits, indicates a decrease in the use of dentition as a tool, a less abrasive and more varied diet than had been previously suggested.

The ecological diversity of paleoprimates communities from African Pliocene hominin-bearing localities. B. M. MCBRATNEY & K. E. REED, Institute of Human Origins, Department of Anthropology, Arizona State University, Tempe, AZ 85287

Most hominin-bearing localities from the African Pliocene have produced an array of fossil primate species. Taxonomically, the composition of these fossil communities is quite different from extant African primate communities. In this study we compare these paleoprimates localities with extant African communities from various habitats to determine if there are also major ecological differences between the Pliocene and extant localities.

Morphological variables related to trophic and locomotor adaptations were derived from 42 extant primates within 15 extant primate communities ranging from forest to grassland habitats. These variables, along with body size data, were incorporated into a principle coordinates analysis (PCO), and the first two factors were plotted to summarize the ecological space held by all extant communities. The same morphological information was obtained for the fossil primates, and each fossil locality was incorporated into the PCO to determine its ecological diversity and shape compared with the extant communities.

Results of the extant study show that broad, diverse ecological space is occupied by modern forested communities, each of which includes seven to 15 primates. In contrast, communities in drier environments (three to nine species for each) encompass less two-dimensional space, and fewer taxa occupy each ecological niche. The fossil localities, with species numbers ranging from four to seven, encompass relatively small ecological spaces with apparently low ecological diversity as well. However, location of the space occupied by primates in fossil localities is extremely different from extant communities, showing that, in many respects, these fossil localities lack modern analogues.

A test of methods for sex determination for the os coxae using the ID3 algorithm. D. G. McBRIDE¹, M. T. VENNEMEYER¹, M. J. DIETZ¹, S. A. MEADORS², and R. A. BENFER, Jr.¹. ¹Anthropology, University of Missouri, Columbia, 65211. ²Haskell Indian Nations University, Lawrence, Kansas, 66046.

The number of secondary sexual characteristics and the order and manner of their application to estimating sex from human bone is investigated by comparing the performance of 31 such characters, as well as character subsets, using

Bootstrap (resampling) methods. Using Shannon's Information Statistic as a criterion for an inductive procedure (ID3) that creates relatively short decision trees, we show many fewer than the 31 total characters provided better identification by sex than either the full set or subsets suggested by experts.

Using the os coxae of each of 115 individuals of known sex and approximately equal representation by decades, selected from the Terry collection, a total of 31 observations were made according to methods described by three well known skeletal experts. Ten Bootstrap sampling trials were conducted with replacement and analyzed using an ID3 algorithm. Three types of tests were conducted: (1) all 31 criteria were combined to evaluate relative influences in sex determination, (2) the set of characteristics preferred by each skeletal expert was considered separately to determine overall effectiveness, and (3) individual observations were removed in a stepwise procedure and ordered by ID3 to evaluate the optimal combination of sexually diagnostic characters.

When all 31 observations, and selected subsets, were used, success in 10 trials in which the model was developed from 70% of the randomly selected cases and tested on the remaining 30% ranged between 84.6% and 100%, with a mean accuracy of 92.4%. Three subsets, each comprised of the four most successful indicators described by the three skeletal experts, provided mean accuracies of 89.5%, 88.5%, and 84.6%.

This study demonstrates that a smaller set of characters, selected and ordered by ID3, are more accurate than other combinations. The utility of the ID3-developed decision trees is illustrated by the ability to provide good assignment in the test sets. The combination of ID3, developed from Bootstrapped examples and validated with a training set/test set design, is a useful approach for developing identification systems.

Cranial base architecture and the scaling relationships of the anthropoid skull. R.C. McCARTHY, Doctoral Program in Hominid Paleobiology, Department of Anthropology, The George Washington University, 2110 G. Street NW, Washington, DC 20052

Recently there has been disagreement about whether modern humans exhibit the degree of cranial base flexion predicted when brain size is scaled against basicranial length. When the anterior terminus of basicranial length extends to the cribriform plate, modern humans are outliers. However, if the cribriform plate is included in cranial base length, then modern humans conform to a general anthropoid trend. This investigation partitioned the anterior segment of cranial base length into its components in order to determine the morphological basis for these apparently conflicting relationships.

The relationships between A) the length of the sphenoid body, B) the frontal bone contribution to the floor of the anterior cranial fossa, and C) the length of the cribriform plate of the ethmoid to the cube root of endocranial volume were examined in 162 crania from 18 anthropoid species.

The lengths of the bodies of both the sphenoid and the ethmoid scale isometrically with endocranial volume. In contrast, the frontal bone's contribution to the floor of the anterior cranial fossa scales with negative allometry, such that large-brained anthropoids have lesser frontal contribution to the midline. Thus, this negative allometric relationship accounts for the

apparently aberrant behavior of modern humans when cranial base length does not include the ethmoid. Further, because the cribriform plate contributes to the floor of the anterior cranial fossa in anthropoids, the most appropriate measure of relative brain size should include the contribution of the cribriform plate.

Ongoing studies are examining the role of relative orbit size in determining the contributions of the sphenoid, frontal and ethmoid bones to the anterior segment of the cranial base.

Association of low salivary progesterone with low salivary cortisol levels in rural Aymara women. A. MCCLUSKEY, G.R. BENTLEY, U. of Cambridge, V.J. VITZTHUM, SUNY-Binghamton, H. SPIELVOGEL, E. CACERES, Bolivian Institute of High Altitude Biology, La Paz, K. HEIDLEBERG, U. of California, Riverside, R.T. CHATTERTON, Northwestern U., Chicago.

To see if stress might explain significantly lower levels of salivary progesterone (SP) previously reported by us among non-contracepting, rural Aymara women, we used radioimmunoassay to analyze levels of salivary cortisol (SC). We chose a subsample with morning saliva collections, and consecutive ovulatory, non-conception (ONC) and conception cycles (CC) (n=19 ONC, n=12 CC for Aymara; n=20 ONC, n=14 CC in U.S. women for comparison). Two mid-follicular (MF) and mid-luteal (ML) samples were analyzed from these cycles.

Mean levels of SC were significantly lower in rural Aymara compared to US women in both non-conception (505 ± 69 vs. 890 ± 147 pg/ml, $t=2.37$, $p=0.03$) and conception cycles (509 ± 42 vs. 734 ± 125 pg/ml, $t=1.170$, $p=0.05$). Luteal SC levels were significantly higher than follicular levels in both rural Aymara and US women (773 ± 96 pg/ml and 602 ± 81 pg/ml, respectively, [combined data, Aymara and US] $t=2.43$, $p=0.02$). Neither follicular nor luteal levels of SC were different between non-conception and conception cycles (MF, $t=0.04$, $p=0.97$; ML, $t=1.12$, $p=0.28$ [combined data, Aymara and US women]). Luteal SP levels in both non-conception and conception cycles in Aymara women were proportionally lower than SC levels (ONC: obs. ML SP 52 pg/ml vs. exp. 67 pg/ml, $t=1.79$, $p=0.09$; CC: obs. ML SP 102 pg/ml vs. exp. 142 pg/ml, $t=2.23$, $p=0.04$).

Because SC was lower in Aymara than US women, the lower SP cannot be attributed to the kinds of stress that result in chronically elevated SC. The greater difference in SP than SC between these populations evidently results from factors more directly related to reproductive function.

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Human population relationships as assessed via DNA and Protein markers. J. MCCOMB, University of Kansas, and M.H. CRAWFORD, University of Kansas, KS 66045

Over the past two decades, the DNA revolution has produced a number highly polymorphic systems, such as the tandem repeat loci, which have proven to be useful in the study of human population genetics. Thus far, the repetitive loci tend to fall into one of two categories. First, are the VNTR systems whose repeat units are usually over 20 bps. Overall, these systems are usually larger than 2000 bp and are consequently detected via Southern blotting. The second type of system possesses repeat units under 20 bps and is readily amplifiable by PCR. An important question is whether the evolutionary mechanisms which shape the larger systems operate in a similar fashion on the smaller systems.

In addition, it is also important to assess the concordance between the current DNA systems and the protein systems which are presumed to be more affected by natural selection. To examine these relationships we have compiled a data set of individuals from six populations (European American, American Indian, Asian, Altai, Evenki, and Ket). Each individual has been tested in nine protein systems (ACP, ESD, PGM, GC, F13A, F13B, PLG, GM and KM), five VNTR Southern blot systems (D7S104, D11S129, D18S17.1, D20S15 and D21S112) and eight PCR systems (FGA, TH01, VWA, CSF1PO, TPOX, D8S1179, D18S51, D21S11).

Preliminary results indicate that the PCR based loci exhibit a high and constant level of heterozygosity when compared to the protein and the non-PCR based systems (which show more variability in heterozygosity between loci). In addition, the PCR based loci show less variation in allele frequencies between groups than either of the other two systems. Overall, these results may be a function of the markers studied, indicating that each type of marker may give a unique evolutionary picture.

Phylogenetic relationships and paleoecological adaptations of a new bushbaby from the middle Miocene of Kenya. M.L. McCROSSIN, Department of Anthropology, Southern Illinois University, Carbondale IL 62901.

Fossil evidence for the evolutionary history of the Galaginae comes primarily from three intervals: 1) the early Miocene of Kenya and Uganda – *Komba robustus* and *K. minor*, 2) the Pliocene of Ethiopia, Kenya, and Tanzania – *Galago howelli*, *G. sadimanensis*, and cf. *Galagoides*

demidovii, and 3) the early Pleistocene of Tanzania – cf. *Galago senegalensis* (Clark & Leakey 1952; Simpson, 1965, 1967; Wesselman, 1984; Walker, 1987). There are few bushbaby fossils from the time period intervening between the early Miocene and early Pliocene, with only *Komba winamensis* known from the middle Miocene (McCrossin, 1992). A right mandible with M2-3 and a left calcaneum of a bushbaby recently recovered from Maboko Island, Kenya provide significant new information concerning the diversity of galagines during the middle Miocene.

The new bushbaby is diminutive. The area of the second mandibular molar and the size of the posterior astragalar facet indicate a body weight of 30-40 gm, substantially smaller than the estimated body weights of other fossil bushbabies, including *K. minor* – ca. 141 gm, *K. robustus* – ca. 344 gm, and *K. winamensis* – ca. 1138gm (McCrossin, 1992). The new bushbaby may be distinguished from *Komba* by its higher and more pointed molar cusps, relatively longer occlusal crests, deeper and more restricted talonid basins, higher trigonid, and the complete absence of a buccal cingulum. Like *Komba*, the anterior and medial facets of the calcaneum are clearly separated and there is no evidence of the anterior calcaneonavicular synovial joint present in extant galagines. The length of the calcaneum between the anterior and posterior facets is relatively short, as in *Komba* and cheirogaleids (Gebo, 1986), and unlike the greatly elongated anterior calcaneal proportions of living bushbabies. In dorsal view, the heel process is straight as in *Komba* and living bushbabies and unlike the medially curved heel process of KNM-SO 1364 and living lorises and pottos (Gebo, 1986). The new bushbaby appears to have been highly insectivorous and to have used a cheirogaleid-like pattern of positional behavior.

Jaws and diet among colobines: A biomechanical enigma. W.S. MCGRAW, Department of Anatomy, NYCOM, Old Westbury, NY 11568 and D.J. DAEGLING, Department of Anthropology, Yale University, New Haven, CT 06520.

A profusion of comparative studies has related mandibular size and shape variation to dietary differences among primates. While the functional linkage between bony morphology and masticatory mechanics has been established, there remains uncertainty over how finely differences in jaw form can be unambiguously coupled to species-specific feeding behaviors. It is therefore reasonable to expect that nonmechanical aspects of craniofacial biology can influence morphology so that trophic distinctions are obscured.

Three sympatric species of the genus *Colobus* (*C. badius*, *C. polykomos* and *C. venus*) from Ivory Coast's Tai forest are known to have distinct feeding preferences. In particular, *C. polykomos* seasonally exploits the seeds of the tough fruit *Pentaclethra macrophylla*, a food item routinely shunned by its congeners. From an explicitly biomechanical perspective, it is predicted that the jaws of *C. polykomos* will exhibit a suite of morphological

features related to relatively large masticatory forces which will be absent in *C. badius* and *C. venus*.

From linear measurements on jaws of free-ranging male and female adults, several biomechanical indices were calculated for the three species to relate dietary preferences to differences in mandibular size and shape. Strain gage analyses on dry mandibles of *C. polykomos* and *C. badius* were used to evaluate the validity of theoretical models used in the selection of biomechanical indices.

The hypothesis that the diet of *C. polykomos* is associated with a functionally "robust" mandible is only incompletely supported. Moreover, intraspecific dimorphism is associated with large differences in masticatory capabilities. We conclude that a strictly mechanical explanation for morphological differences among these taxa is not tenable.

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Hominoid insectivory: Meta-analysis of optimal foraging. W.C. MCGREW, Anthropology and Zoology, Miami University, Oxford, OH 45056

Hominoids (living and extinct, including *H. sapiens*) are characterized as omnivores, because of their broad diets that include herbivory and faunivory. The latter is usually thought of as the consumption of vertebrate flesh, i.e. carnivory, in evolutionary accounts of hominization. Debates on (e.g.) hunting versus scavenging typically ignore or minimize the contribution of invertebrates to diet, although per unit weight, these are just as nutritionally beneficial.

Systematic meta-analysis of ethnographic accounts of human tropical foragers (in Africa, Australia and the Neotropics), and of ecological results from field studies of African great apes show remarkable convergence. All such hominoids concentrate on just five orders (Coleoptera, Hymenoptera, Isoptera, Lepidoptera, Orthoptera) of the arthropod Class Insecta. Within these, only a few families are preyed upon, to the exclusion of the vast majority of others, these being prey concentrated in large but ephemeral patches (social caterpillars), small and dispersed but easily processed and common items (gall wasps), solitary but large and immobile larvae (wood-boring beetles), or eusocial insects of high-collective biomass whose defenses can be overcome by technological extraction (honey bees).

When humans are more efficient at harvesting such resources, it is by cognitively-based techniques, rather than by morphological adaptation.

Reconstructing health and disease in a population from Canyon de Chelly. R. MCGURK and A.L. GRAUER, Department of Sociology and Anthropology, Loyola University of Chicago, Chicago, IL 60626.

An analysis of 40 skeletons excavated from Canyon de Chelly, New Mexico has revealed

complex demographic and pathological patterns. This paper explores these patterns in an effort to reveal the subsistence strategies of the population and to gain insight into the presence of stressors.

The result of the demographic analysis indicates that 48% (19/40) of the skeletal population is below the age of 15, and that the majority of these juveniles are 2-5 years old ($n=15$). Results of the paleopathological analysis reveals that 60% (24/40) of the population displays porotic hyperostosis, and 10% (4/40) exhibits periosteal reaction. Enamel hypoplasias are found on 13% (1/8) of the individuals with a permanent canine, and 70% (7/10) of the individuals with a permanent molar display caries.

These data are compared to other skeletal analyses of southwestern populations. While similarities are found, differences are also apparent and are examined in order to explore the role that environment and nutrition played in the health and disease of this population.

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Limb Lengths and Missing Links: Body Proportions in *Australopithecus*. HENRY M. McHENRY, Anthropology, University of California, Davis, CA 95616

The discovery in the late 1940s of australopithecine pelvic bones convinced Dart and others that, in his words these hominids had "Heads of apes and bodies of men." Dart, Robinson and many others emphasized the humanness of the body of *Australopithecus africanus*. New discoveries, however, reveal some surprises. Of particular importance is the discovery of a partial skeleton, Stw 431, that has much larger forelimb joints than expected from its small sacrum and hip. Unfortunately, this specimen does not preserve enough of the limb-shafts to allow direct measurement of limb lengths.

This study reconstructs limb lengths of *Australopithecus* species using reduced major axis formulae derived from modern species of Hominoidea. It also uses all available fossil specimens to check the reliability of the reconstructed lengths.

The results show that the proximal humerus predicts the same humeral length using human and African ape samples. The African ape sample of distal humeri, proximal radii, proximal and distal ulnae, proximal and distal femora, and proximal tibiae yield formulae that predict shorter lengths than those based on the human sample. Relatively complete fossil limbs show that in some instances (e.g. A.L. 288-1 proximal humerus) the length exceeds what is expected from either human or ape samples. In other cases (e.g. the distal humeri of A.L. 288-1, KNM-ER 739, & KNM-WT 15000; the proximal radius of KNM-ER 3956; and the proximal femur of KNM-ER 1472 & WT 15000) the human sample predicts a more appropriate length. In some specimens (e.g. proximal and distal ulna measures of Omo L40-19 and proximal radial size of KNM-ER 20419 and SKX 3602) the ape sample produces a better estimate of total length.

From these considerations it appears that *A. africanus* probably did have much longer forelimbs than expected from

the length of its hindlimbs. There is some evidence that these proportions were more ape-like than those seen in earlier and craniodentally more primitive species of *Australopithecus* (i.e. *afarensis* and *anamensis*). This may imply that there was extensive homoplasy in craniodental traits or that the postcranial proportions were more phylogenetically labile than previously recognized.

Biogeography of Pliocene and Pleistocene African large mammals and faunal dating of southern African hominids. J.K. MCKEE, Department of Anthropology, The Ohio State University, Columbus, Ohio, 43210.

Comparisons of the fossil records from eastern and southern African reveal a shared component of only 10% of known large mammal species. This indicates long-term biogeographic and ecological distinction between the two subcontinents, posing difficulties for faunal dating of the southern African sites. The problems are compounded in that the average longevity of shared fossil species is about 2 myr at East African sites (almost double the average of unshared species), meaning that few species can be used as valuable temporal markers.

With these caveats in mind, probable age ranges for South African fossil sites were calculated on the basis of the most parsimonious ages encompassing the large mammal fauna shared with East Africa. The dates were then refined on the basis of data from site stratigraphy and chronological seriations of the southern African assemblages.

The resulting proposed age ranges for South African hominids are: *Australopithecus africanus* 3.1-2.6 mya; early *Homo* 2.0-1.8 mya; *A. robustus* 2.0-1.0 mya; *Homo erectus* 1.8-1.0 mya; and Archaic *Homo sapiens*, 0.9-0.6 mya.

Using the faunal dates, the majority of shared large mammal species first appear in East Africa, even during well-sampled time intervals after 3 mya. The East African species also appear in the fossil record for longer intervals, and each time period has greater species diversity. It is unclear whether this is an artifact of the fossil records, or if the generation and maintenance of biodiversity is greater in East Africa.

Investigating intracemetery variation at the Sully site (39SL4), South Dakota, via the "New Morphometry". A.H. MCKEOWN, Department of Anthropology, University of Tennessee, Knoxville, TN 37966

Archaeological evidence indicates that the spatially distinct burial areas at the early Post-Contact Coalescent Sully site (39SL4), South Dakota, are the result of several occupation periods between 1600-1750 A.D. Previously, Owsley and Jantz (1978) attempted to discern the chronological sequence of the burial areas employing variation in cranial morphology as assessed through traditional morphometric methods. While their

research determined that significant morphological variation did exist between the burial areas and a temporal sequence could be established, their traditional morphometric approach did not describe the morphological variation that discriminated between burial areas.

Since that time, new methods in morphometrics allow for the analysis of three-dimensional or Cartesian coordinate landmark data. This "new" or geometric morphometry captures more information about the biological form, particularly with reference to shape, providing a more accurate picture of exactly where (i.e. at which landmarks) variation occurs as well as quantifying the magnitude and direction of the variation.

An investigation into the morphological variability between burial areas at Sully site was conducted using three dimensional landmark data and geometric morphometric methods. Landmark coordinates were collected on 105 crania from the Sully site utilizing a MicroScribe-3DX digitizer. All specimens were brought into a common coordinate system with a least squares superimposition method found in GRF-ND written by Dennis Slice of SUNY at Stony Brook. Based on group membership as determined by burial location, average group forms were generated and a generalized distance was derived across all specimens providing for classification of each specimen per their proximity to any group mean. Comparison of the average forms provides a pictorial representation of the cranial morphology that varies between the burial areas.

Effects of age and body composition on average glycemia among Maya females in rural Yucatan. PA MCLORG, Department of Anthropology, Southern Illinois University, Carbondale IL 62901-4502.

Age-related decline in glucose processing, associated with progressively higher circulating blood sugar levels, is considered common in human biological aging. Yet, its occurrence in nonwesternized populations experiencing less mechanization and industrialization has not been well studied. This research investigates glucose handling with age in a nonwesternized setting in rural Yucatan, Mexico. Aging patterns in average glycemia among middle-aged and older Maya females are considered in the context of body composition factors relevant to glucose regulation.

Data were gathered from 60 Maya women living in 16 rural villages around Merida, Yucatan. The age range of respondents is 40 to 85 years, with an even distribution of participants in age groupings 40-54, 55-69, and 70-85. Anthropometric measures of body composition include weight, stature, and six circumferences of the upper and lower limbs and trunk. From the collected data, several ratios and indices are derived to indicate fat distribution, body shape, and overall fitness. In addition, appropriate prediction equations are applied to estimate fat and fat-free mass and components of abdominal fat. Indicators of blood glucose were obtained through micro venous samples analyzed for glycated hemoglobin and fructosamine. These glycated blood proteins reflect average levels of circulating

glucose in usual living conditions over the previous 2 to 3 months (for glycated hemoglobin) and the previous 2 to 3 weeks (for fructosamine).

Results demonstrate that age is not significantly related to glycated protein levels. Age is negatively correlated with several body size measures, including all circumferences, body mass index, fat mass, and fat-free mass, while central distribution of fat is positively associated with age. Significant positive predictors of fructosamine, but not of glycated hemoglobin, include upper arm and umbilicus circumferences and estimated intra-abdominal fat. The lack of age-related decline in glucose processing and other findings are relevant to comparative biological aging, including examinations of westernization.

Phylogenetic effects and the problem of nonindependence in comparative analysis.

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Many modern analytical techniques when applied to cross-taxonomic data violate the assumption of statistical independence, an occurrence that can lead to an increase in the Type I error rate and erroneous inferences regarding hypothesized relationships among phenotypic traits. Numerous methods have been proposed for "removing phylogenetic effects" inherent in cross-taxonomic data thereby restoring independence. However, the meaning of the adjusted data and the conceptual and statistical relationships among different methods have never been adequately explored.

It will be shown that all valid methods of restoring independence to comparative data (including independent contrasts, nested ANOVA and autoregression) reduce to a single conceptual and analytical model—the Ancestrally Centered Phylogeny (ACP)—in which a multi-level phylogeny is collapsed into a single-level phylogeny. Once this is understood, the meaning of the adjusted data becomes clear: each adjusted variate represents the amount and direction of change in a given trait that has accrued over a lineage from a specified ancestor to its extant descendent. Within this framework it will be shown that GLM-based phylogenetic adjustment methods are simply techniques that estimate the ancestral morphotypes required of the ACP model. This implies that analyses using phylogenetically adjusted data are inherently vertical rather than horizontal, and opens the door for use of well preserved fossil specimens in comparative studies. A method for incorporating fossil data into a phylogenetic autoregression analysis using a rectangular *W* matrix will be presented.

The efficacy and properties of several phylogenetic adjustment methods will be assessed using virtual data from computer simulated phylogenies and actual craniometric data from a sample of anthropoids ($n=300$). Analysis of the simulated data showed that while none of the methods fully restored statistical independence (i.e., Type I error rate > 0.05), several methods significantly reduced the Type I error rate (from 0.30 to 0.10). Analysis of the anthropoid data correlation matrix revealed a decrease in the rate of significant correlations from 31% using raw data to 14% with phylogenetically adjusted data. Other important properties of the methods will be compared and discussed.